Annals of Clinical and Analytical Medicine
Original Research

An outbreak of septic arthritis after arthroscopic reconstruction of the anterior cruciate ligament

Septic artritis after surgery

Güliz Evik[1], Gülcan Türkmen[2], Fatma Bozdağ[3], Mehmet Çolak[4], Gülden Ersöz[5]
[1] Department of Infectious Diseases, Faculty of Medicine, Mersin University
[2] Department of Nursing, Mersin University Hospital
[3] Department of Public Health, Faculty of Medicine, Mersin University
[4] Department of Orthopaedics and Traumatology, Faculty of Medicine, Mersin University
[5] Department of Infectious Diseases, Faculty of Medicine, Mersin University, Mersin, Turkey

Abstract
Aim: Acute septic arthritis after arthroscopic posterior cruciate ligament (PCL) reconstruction is uncommon but is a very critical complication. Properly sterilized surgical instruments are the most important step in preventing infection. After arthroscopic anterior cruciate ligament surgery, a cluster of 6 joint-bursa infection cases was seen in our unit. The aim of this study was to determine the socio-demographic and clinical practices that may be associated with the development of infection in the surgical site after arthroscopic cruciate ligament surgery.
Material and Methods: This was a cross-sectional study of SSIs developing after arthroscopic anterior cruciate ligament surgery in 2018 in a University Hospital. Environmental and surgical equipment samples were taken. ATP bioluminescence test was performed on these samples. When a high-risk status was detected, surveillance cultures were performed.
Results: A total of 15 procedures meeting the inclusion and exclusion criteria were evaluated. Six patients were considered to have infections, while 9 were infection-free. An examination of the surgery lists showed that 6 of the 7 patients with infection represented the first arthroscopic procedure of the day. An inquiry regarding personnel of the surgery room showed that a newly appointed nurse made a modification in the decontamination procedure of the surgical equipment.
Discussion: Incomplete sterilization of surgical equipment and environmental contamination can lead to serious infection.

Keywords
Arthroscopic Surgery, Anterior Cruciate Ligament, Septic Arthritis, Outbreak

DOI: 10.4328/ACAM.21699 Received: 2023-03-22 Accepted: 2023-05-05 Published Online: 2023-08-05 Printed: 2023-11-01 Ann Clin Anal Med 2023;14(11):976-980
Corresponding Author: Güliz Evik, Department of Infectious Diseases, Faculty of Medicine, Mersin University, 33343, Mersin, Turkey.
E-mail: gulizevik@gmail.com P: +90 536 557 09 33
Corresponding Author ORCID ID: https://orcid.org/0000-0003-2125-3536
This study was approved by the Clinical Research Ethics Committee of Mersin University (Date: 2022-02-23, No: 148)

Introduction

Infections represent a rare complication following arthroscopic anterior cruciate ligament reconstruction, with a reported incidence between 0.15% and 0.45% [1-4].

Despite these low incidence rates, early recognition of these infections has considerable clinical significance, as they may lead to severe and irreversible consequences such as graft and hyaline cartilage loss as well as arthrofibrosis. Thus, prompt initiation of treatment is essential [5].

Although septic arthritis is generally a sporadic event following arthroscopic surgery, several case series and outbreaks have been reported [6-8].

Current orthopedic practice requires the sterilization of reusable devices (critical devices) with traditional methods and the documentation of compliance with standards with respect to all decontamination steps as well as cleansing and disinfection procedures prior to sterilization. According to the disinfection and sterilization guidelines in healthcare facilities, the main sources of surgical site infections (CAE) include inadequate decontamination and microorganisms that survive in a biofilm layer that cannot be removed from the surface of surgical equipment. (available at: https://stacks.cdc.gov/view/cdc/47378)

The high percentage of compliance with manual standard applications for the use of reusable medical devices can help hospitals minimize the risk of transmitting pathogens to medical devices [10].

Orthopedic surgery requires a highly sterile environment to prevent joint infection. Ensuring that surgical instruments are sterilized is of great importance in preventing post-operative surgical infection. Although septic arthritis is relatively rare after anterior cruciate ligament reconstruction, orthopedic surgeons are likely to encounter difficult-to-treat patients.

In this study, a clustering of infections of the articular-bursa following arthroscopic anterior cruciate ligament surgery in our unit has been assessed in light of the literature.

Material and Methods

Epidemiological Investigation

This was a cross-sectional study of SSIs developing after arthroscopic anterior cruciate ligament surgery between 1 July and 31 August 2018 in a University Hospital setting. The study was approved by the Mersin University Clinical Research Ethics Committee. Due to the retrospective nature of the study, informed consent was waived. Patients over 18 years of age and undergoing elective arthroscopic cruciate ligament surgery were included. Exclusion criteria were additional procedures other than arthroscopic surgery, history of trauma or surgery within the past month, prosthetic surgery within the past year, and age under 18 years.

The dependent variable of the study was infection at the site of surgery after arthroscopic cruciate ligament surgery, while the independent variables were age, gender, room of surgery, duration of surgery, the surgeon performing the procedure, as well as the number of patient's procedure on the daily surgery list and the number of patient's procedure in the daily arthroscopy list.

Study data were statistically analyzed in a computer environment. Data were summarized using descriptive statistics (mean, standard deviation, minimum and maximum). Comparison between categorical variables was performed using the chi-square test, while Fisher's exact test was used when any of the values were below five in the table. The significance of the continuous and categorical variables was investigated with the Mann-Whitney U test. A p-value of less than 0.05 was considered statistically significant.

Investigation of the outbreak

Procedures prior to and following arthroscopic surgery were subjected to a comprehensive examination in order to identify the source of infection. Surgery room, surgical sets utilized, and sterilization steps of the arthroscopic devices were assessed. Samples for microbiological cultures were obtained from all potential areas of contamination. ATP bioluminescence test was performed on the samples obtained from the surroundings such as trocars, shaver tips, set clamps, surgical stretchers, anesthesia table, computer keyboards, and mobile phones in addition to inside and outside of sterile instrument packages of the material company. When a high-risk status was detected, surveillance cultures were performed. Also, the medical personnel and their activities within the surgical environment have been observed with respect to potential risky behaviors.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

Epidemiological results

Patients undergoing arthroscopic cruciate ligament surgery in a university hospital between July and September 2018 were examined. A total of 15 procedures meeting the inclusion and exclusion criteria were evaluated.

Thirteen cases (86.7%) were male and 2 (13.3%) were female, and the mean age of participants was 26.07 ± 8.51 years (min: 18, max:41). All patients underwent cruciate ligament surgery. Of these cases, 8 (53.3%) were operated in the first orthopedic surgery room, while 2 (13.4%) were operated in the second orthopedic surgery room, and others were operated in other surgical rooms (neurosurgery 1, cardiovascular surgery 1, gynecology 1, algology 2). The mean duration of surgery was 64.93 ± 17.55 minutes (min: 40, max: 105). Two procedures (13.3%) were performed by Surgeon A, 11 (73.4%) by Surgeon B, and 2 (13.3%) by Surgeon C. Ten patients (66.7%) were first on the surgery list, while 2 (13.3%) were second, 2 (13.3%) were fifth, and one (6.7%) was seventh on the surgery list. Twelve (80.0%) patients underwent the first arthroscopy on that day, and 3 (20.0%) had the second. Table 1 shows the data for the two groups.

Among patients presenting with knee pain after surgery, a microbiological sample was obtained from the knee joint in three that showed the growth of Enterobacter aerogenes in all three (resistant to amoxicillin clavulanic acid and ampicillin), Klebsiella oxytoca (resistant to amoxicillin clavulanic acid, cefoxitin, and ampicillin) in one, and methicillin-susceptible coagulase-negative staphylococcus. In the other three patients presenting with pain, erythrocyte sedimentation rate (ESR) was 43 mm/hr, 41 mm/hr, and 45 mm/hr; c-reactive protein (CRP) was 155.8mg/dl, 129.0 mg/dl, and 65.86 mg/dl, and white blood

cell count (WBC) was 8.08/mm3, 14.20/mm3, and 12.22/mm3, respectively. ESR in two of the other nine operated patients was 4 mm/hr and 17 mm/hr, respectively; no post-surgery laboratory data were available in the remaining 7 patients. These subjects were contacted by phone calls and reported no symptoms. Thus, 6 patients were considered to have infections, while 9 were infection-free.

No significant association between age and infection was observed (z=-0.59, p=0.95), as was the case for the duration of surgery and infection (z=-0.932, p=0.35).

Results of the Outbreak Analysis

An examination of the surgery lists showed that 6 of the 7 patients with infection represented the first arthroscopic procedure of the day. An inquiry regarding personnel of the surgery room showed that a newly appointed nurse made a modification in the decontamination procedure of the surgical equipment, which involved sole rinsing with water and prolonged exposure to external surrounding conditions. Also, high concentrations of disinfectants were used for the sterilization procedure of the arthroscopy devices. There was no growth in samples obtained from surgical equipment and the surgery room, while E. aerogenes was isolated from the tip of the shaver. Also, no growth occurred in samples from solutions. Table 2 shows the organisms isolated and sites of isolation in previous studies.

Table 1. Socio-demographic and surgical data among patients developing infections after arthroscopy.

	Infected		Normal		Total		x^2
	n	%	n	%	N	%	p
Gender							
M	5	38.5	8	61.5	13	100.0	0.096
F	1	50.0	1	50.0	2	100.0	1.0
Surgery room							
Orthopedics 1	2	25.0	6	75.0	8	100.0	
Orthopedics 2	1	50.0	1	50.0	2	100.0	8.420
Gyn. and Obst.	1	100.0	0	0.0	1	100.0	
CVS surg.	1	100.0	0	0.0	1	100.0	
Neuro-surgery	1	100.0	0	0.0	1	100.0	0.13
Algology	0	0.0	2	100.0	2	1000	
Surgeon							
A	2	100.0	0	0.0	2	100.0	5.770
B	4	36.4	7	63.6	11	100.0	
C	0	0.0	2	100.0	2	100.0	0.06
No. of surgery							
1	3	30.0	7	70.0	10	100.0	7.973
2	0	0.0	2	100.0	2	100.0	
5	2	100.0	0	0.0	2	100.0	0.04
7	1	100.0	0	0.0	1	100.0	
No. of arthroscopy							
1	6	50.0	6	0.0	12	100.0	2.500
2	0	0.0	3	100.0	3	100.0	0.23
Total	6		9		15		

Table 2. Organisms isolated and sites of isolation in previous studies.

Year of publication	No of cases	Causative pathogen	Source of outbreak
200014	10	KNS	Sterile inflow cannula
201018	13	MSSA, most frequent (7)	Failure to provide effective sterilization
198715	3	MSSA, KNS	Surgical preparation area
19997	3	CNS	Cannula
20099	7	Pseudomonas	Shaver, cannula

Discussion

Among the orthopedic procedures, hip and knee implantation surgeries are frequently performed and should be prospectively followed up with regard to surgical site infections (SSIs), as they represent major surgical operations. However, the requirement to follow the possible occurrence of SSIs prospectively is frequently overlooked in arthroscopic procedures due to the low risk of infections, leading to retrospective assessments when such infections are observed in a particular surgery unit.

Although septic arthritis is a rare occurrence following anterior cruciate ligament repair, it may lead to serious complications such as graft failure or arthro-fibrosis [1].

Infections after anterior cruciate ligament repair may arise due to a number of different causes. Reported risk factors for septic arthritis include previous surgery on the operated knee, prolonged surgery, extensive incisions, inflammation due to prolonged tourniquet application, foreign body effect due to sutures, and use of graft material [10,11].

Other potential risk factors include the use of intra-articular steroids [12].

Furthermore, failure to perform effective sterilization of surgical equipment, environmental contaminants, and noncompliance to surgery room requirements (open doors, excessive number and mobility of the personnel) facilitate the development of SSIs [13,14].

Arthroscopy devices are considered critical equipment and should be sterilized according to the recommendations of the manufacturer. Currently, most arthroscopy devices are sterilized at 134 °C using autoclaves. However, sterilization is performed after completing the essential steps of washing and disinfection. At this point, although ultrasonic cleansing devices are not used for the optical parts due to potential harm, they are utilized for cleaning the cannula. This step requires not only mechanical cleaning, but also the use of enzymatic solutions and disinfectants. One alternative to heat autoclaves is the use of low-heat ethylene oxide or hydrogen-peroxide gas autoclaves, although no recommendations have been provided by manufacturers. Another option is chemical sterilization, which may provide adequate sterilization with the use of high-level disinfectants such as glutaraldehyde or peracetic acid when used in the context of appropriate conditions, heat and duration [15].

Observations performed during the study showed that chemical sterilization was performed in the surgery room to avoid harm during the transfer and sterilization of optical devices and the accompanying cannula, although the surroundings were not

suitable for such procedures leading to certain setbacks. The distinction between clean and dirty areas was not clearly defined, no enzymatic agents were used, and an adequate sterilization heat was not achieved despite the use of peracetic acid. In fact, the failure to detect these setbacks and to implement the required arrangements was mainly due to inadequate training and knowledge on the part of the personnel.

Investigations involving similar infections showed bacterial contamination in the samples obtained from preparatory areas. For instance, Blevins et al. reported contamination in the cannula and growth of MSSA [7]. In another study, pseudomonas was isolated from ECG probe samples [16].

In a previous study on outbreaks after arthroscopic procedures, the source of the infection was the biological load remaining in the lumen of the arthroscopic equipment. In the article by Pritish K. et al., the outbreak was found to result from tissue remnants in the arthroscopic inflow and outflow cannula as well as in the tip of the shaver due to inadequate decontamination prior to re-use [7].

Coagulase-negative staphylococci and Staphylococcus aureus represent the most common causes of septic arthritis after arthroscopic procedures. The source of contamination is very difficult or impossible to detect, since these organisms are part of the skin flora [1,11,16-19].

A review of the 11 publications examining the types of microorganisms, choice of grafting, and treatment protocols in septic arthritis cases after arthroscopic anterior cruciate ligament repair showed microbial growth in 94% of the subjects, 70% of which were due to Staphylococcus aureus and coagulase negative staphylococci [20].

However, in another outbreak report, Pritish K. et al. isolated Pseudomonas aeruginosa in their 7-case series [7].

The cases reported herein were also considered to represent an outbreak. In three of the seven patients, Enterobacter aerogenes was isolated in the joint fluid, while this was accompanied by coagulase negative staphylococci (CNS) in one case, and only CNS was isolated from another patient.

Although several causative pathogens were isolated and the source of infection was identified in our study, certain limitations should be mentioned. Since patients were not followed up in the hospital, some cases might have been unnoticed due to failure to contact with phone calls or due to mild symptomatology. Also, joint fluid sampling could not be performed in all cases, and also sampling was made only after initiation of antibiotics in some others, leading to failure to detect microbial growth. Furthermore, no genotypic comparisons could be made, since the study was retrospective in design and collected samples could not be saved; thus, only phenotypic characteristics such as antibiotic susceptibility and microbial identity could be assessed.

Limitations

The study was based on the examination of patients' medical records. The inability to retrieve postoperative laboratory results in all patients was one of the limitations of our study. Also, the nurses' surgery notes could not be evaluated as they could not be recorded.

Conclusion

Cleaning of medical devices is in line with standard practices, as it significantly reduces the bioburden on the surfaces of medical devices, it can be one of the most important steps for the reuse of medical devices and the prevention of outbreaks.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Funding: *None*

Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

1. Gobbi A, Karnatzikos G, Chaurasia S, Abhishek M, Bulgherhoni E, Lane J. Postoperative Infection After Anterior Cruciate Ligament Reconstruction. Sports Health. 2016;8(2):187-9.

2. Yeranosian MG, Petrigliano FA, Terrell RD, Wang JC, McAllister DR. Incidence of postoperative infections requiring reoperation after arthroscopic knee surgery. Arthroscopy. 2013;29(8):1355-61.

3. Calvo R, Figueroa D, Anastasiadis Z, Vaisman A, Olid A, Gili F, et al. Septic arthritis in ACL reconstruction surgery with hamstring autografts. Eleven years of experience. Knee. 2014;21(3):717-20.

4. Salzler MJ, Lin A, Miller CD, Herold S, Irrgang JJ, Harner CD. Complications after arthroscopic knee surgery. Am J Sports Med. 2014;42(2):292-6.

5. Hogan CJ, Fang GD, Scheld WM, Linden J, Diduch DR. Inhibiting the inflammatory response in joint sepsis. Arthroscopy. 2001;17(3):311-15.

6. Babcock HM, Carroll C, Matava M, L'ecuyer P, Fraser V. Surgical site infections after arthroscopy: Outbreak investigation and case control study. Arthroscopy. 2003;19(2):172-81.

7. Blevins FT, Salgado J, Wascher DC, Koster F. Septic arthritis following arthroscopic meniscus repair: a cluster of three cases. Arthroscopy. 1999;15(1):35-40.

8. Tosh PK, Disbot M, Duffy JM, Boom ML, Heseltine G, Srinivasan A, et al. Outbreak of Pseudomonas aeruginosa surgical site infections after arthroscopic procedures: Texas, 2009. Infect Control Hosp Epidemiol. 2011;32(12):1179-86.

9. Panta G, Richardson AK, Shaw IC, Coope PA. Compliance of primary and secondary care public hospitals with standard practices for reprocessing and steam sterilization of reusable medical devices in Nepal: findings from nation-wide multicenter clustered audits. BMC Health Serv Res. 2020;7;20(1):923.

10. Mouzopoulos G, Fotopoulos VC, Tzurbakis M. Septic knee arthritis following ACL reconstruction: a systematic review. Knee Surg Sports Traumatol Arthrosc. 2009;17(9):1033-42.

11. Bauer T, Boisrenoult P, Jenny JY. Post-arthroscopy septic arthritis: Current data and practical recommendations. Orthop Traumatol Surg Res. 2015;101(Suppl. 8):S347-50.

12. Armstrong RW, Bolding F. Septic arthritis after arthroscopy: the contributing roles of intraarticular steroids and environmental factors. Am J Infect Control. 1994;22(1):16-8.

13. Viola R, Marzano N, Vianello R. An unusual epidemic of Staphylococcus-negative infections involving anterior cruciate ligament reconstruction with salvage of the graft and function. Arthroscopy. 2000;16(2):173-7.

14. Schuster P, Schulz M, Immendoerfer M, Mayer P, Schlumberger M, Richter J. Septic Arthritis After Arthroscopic Anterior Cruciate Ligament Reconstruction: Evaluation of an Arthroscopic Graft-Retaining Treatment Protocol. Am J Sports Med. 2015;43(12):3005-12.

15. Ling ML, Ching P, Widitaputra A, Stewart A, Sirijindadirat N, Thu LTA. APSIC guidelines for disinfection and sterilization of instruments in health care facilities. Antimicrob Resist Infect Control. 2018;20;7:25.

16. Armstrong RW, Bolding F. Septic arthritis after arthroscopy: the contributing roles of intraarticular steroids and environmental factors. Am J Infect Control. 1994;22(1):16-8.

17. Wang C, Lee YH, Siebold R. Recommendations for the management of septic arthritis after ACL reconstruction. Knee Surg Sports Traumatol Arthrosc. 2014;22(9):2136-44.

18. Hantes ME, Raoulis VA, Doxariotis N, Drakos A, Karachalios T, Malizos KN. Management of septic arthritis after arthroscopic anterior cruciate ligament reconstruction using a standard surgical protocol. Knee. 2017;24(3):588-93.

19. Wang C, Ao Y, Wang J, Hu Y, Cui G, Yu J. Septic arthritis after arthroscopic anterior cruciate ligament reconstruction: a retrospective analysis of incidence, presentation, treatment, and cause. Arthroscopy. 2009;25(3):243-9.

20. Saper M, Stephenson K, Heisey M. Arthroscopic irrigation and debridement in

the treatment of septic arthritis after anterior cruciate ligament reconstruction. Arthroscopy. 2014;30(6):747-54.

How to cite this article:
***Güliz Evik, Gülcan Türkmen, Fatma Bozdağ, Mehmet Çolak, Gülden Ersöz.** An outbreak of septic arthritis after arthroscopic reconstruction of the anterior cruciate ligament. Ann Clin Anal Med 2023;14(11):976-980*

This study was approved by the Clinical Research Ethics Committee of Mersin University (Date: 2022-02-23, No: 148)